Oroville Facilities Relicensing
Operations Modeling Workshop #2

August 12, 2003

Workshop Agenda

- Welcome and Introduction
- Operations Modeling for Oroville Relicensing
- Benchmark Study – Part 1
- Lunch
- Benchmark Study – Part 2
- Discussion
- Next Steps
- Adjourn

Workshop Purpose and Objectives

- Understand the operations modeling process, and coordination
- Understand the purposes and results of the Benchmark Study developed for relicensing
- Understand how operations models support relicensing

Participation Principles

- Participate – Attend the Workshop
- Learn – Learn about resources, people, roles, and process
- Represent – Bring issues and interests forward from others whose interests you share
- Cooperate – Work with others in the Workshop to share information and consider options
- Educate – Report back to others who share your interests

Workshop Ground Rules

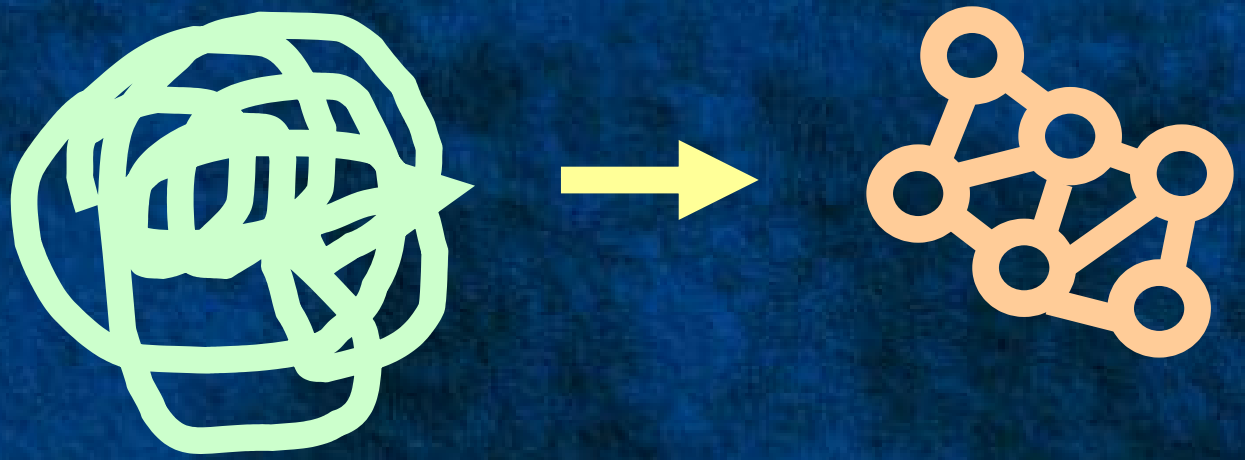
- Commit to Being Fully Present
  - No cell phones, pagers, voicemail, etc.
  - Ask for what you need from the seminar and participants
- Honor Our Time Limits
  - Keep comments and discussion concise
  - Stay focused on the topic – Use the parking lot for other issues
- Respect Each Other
  - Listen carefully to other participants
  - Respond to ideas and issues, not individuals
- Support Constructive Discussion
  - Suggest improvements and solutions
  - Build on others' ideas – Use "and" instead of "but"

Workshop Agenda

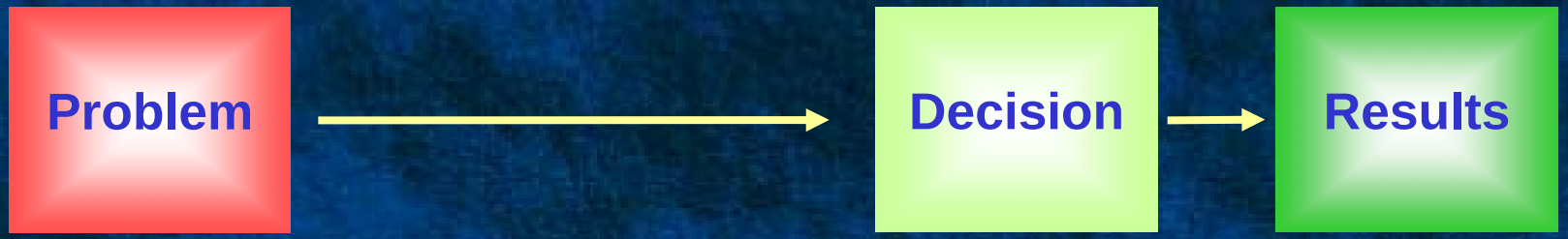
- Welcome and Introduction
- Operations Modeling for Oroville Relicensing
  - Why do we model?
  - What do we use to model?
  - How shall we use the models?
- Benchmark Study – Part 1
- Lunch
- Benchmark Study – Part 2
- Discussion
- Next Steps
- Adjourn

What Is a Model?

- Model *n.* A system of postulates, data, and inferences presented as a mathematical description of an entity or state of affairs (Merriam-Webster's Collegiate Dictionary)

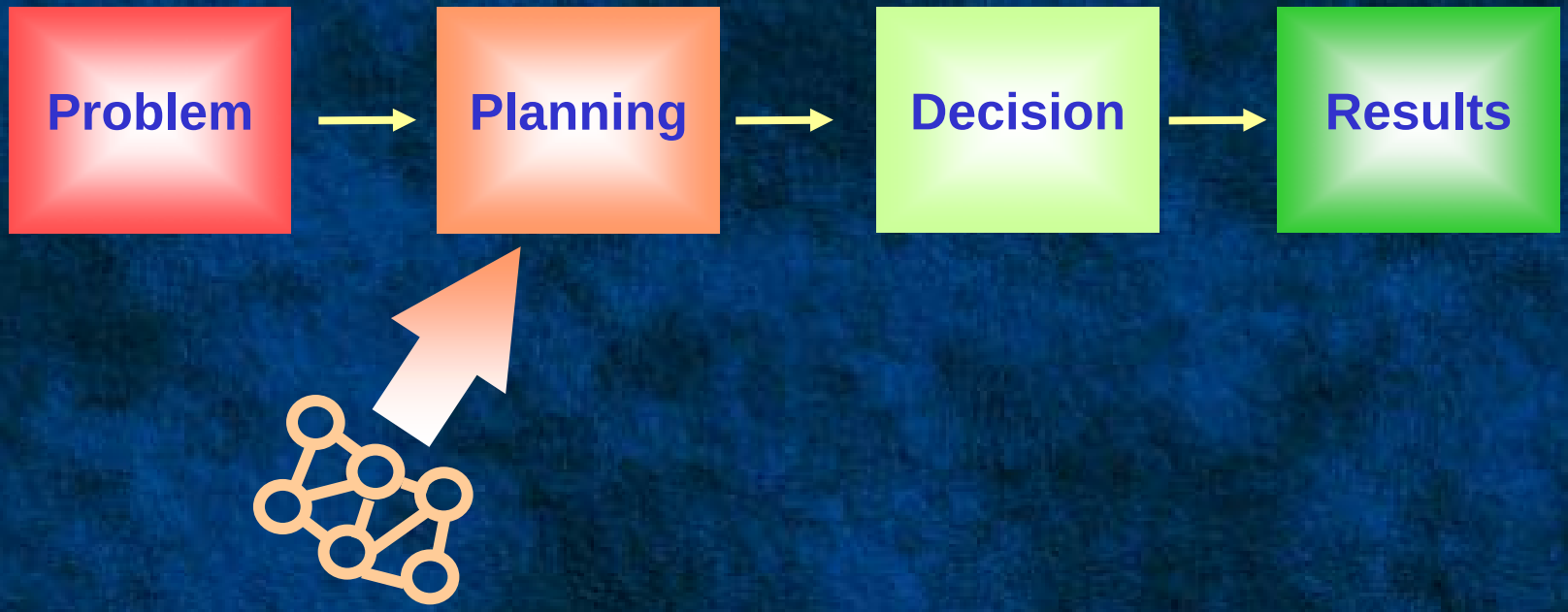


Why Do We Use Models?



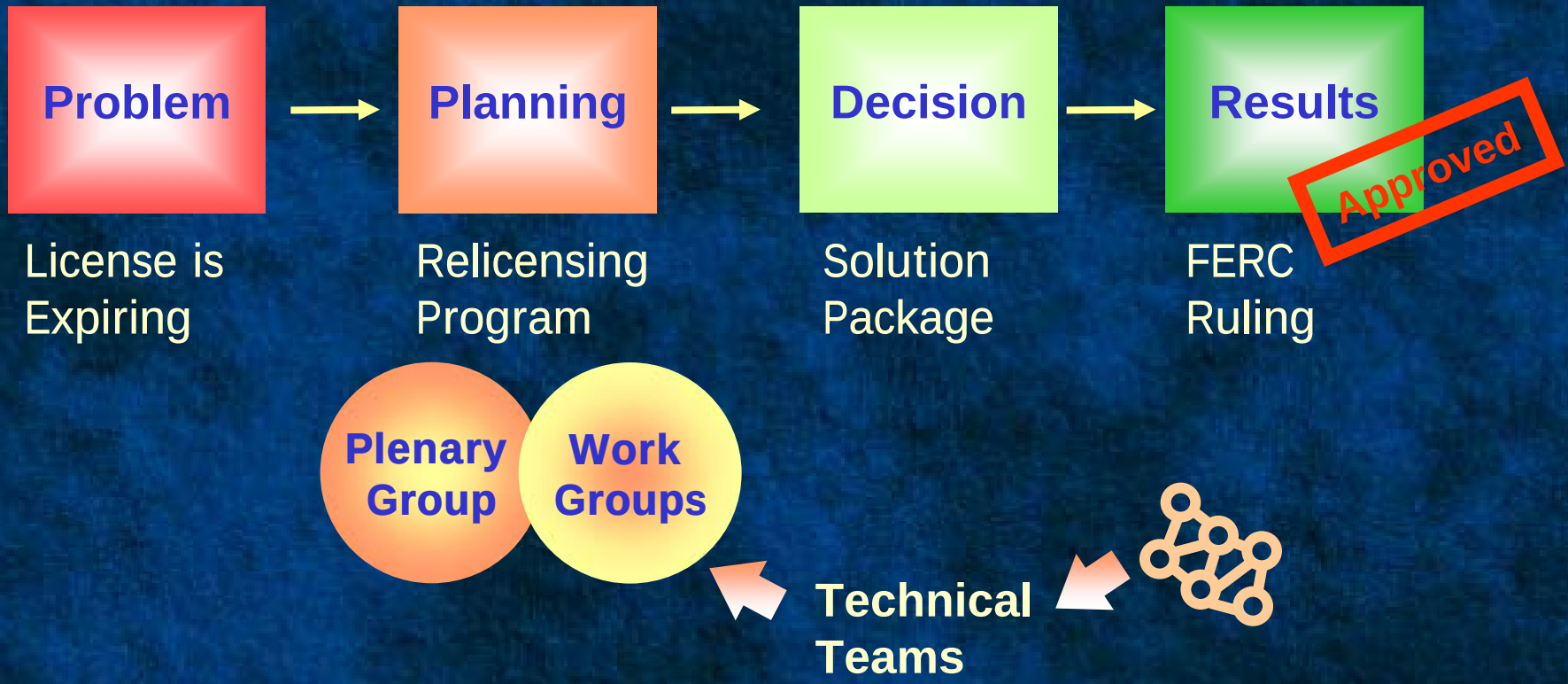
Why Do We Use Models?

- Model is used to answer “What if?”



Why Do We Use Models?

- Oroville Facilities Relicensing



Operations Modeling Suite

CALSIM II

HYDROPS

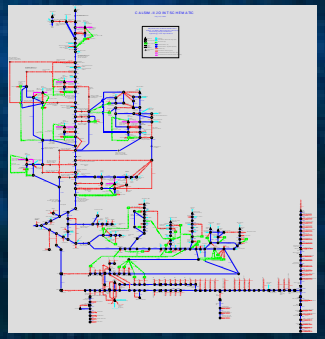
WQRRS

HEC-RAS

Operations Modeling Suite

CALSIM II | **HYDROPS** | **WQRRS** | **HEC-RAS**

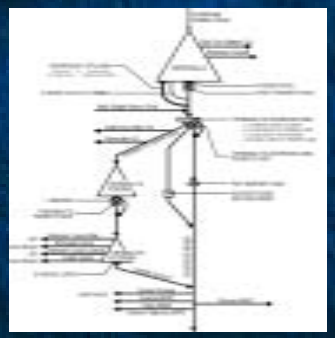
- Statewide CVP/SWP operations model
- Monthly time-step
- Simulate water supply for 73 years
- Subject to
  - Historical hydrology with synthetic upstream impairments
  - Constant “level of development”
  - Existing laws, regulations, policies, contracts, etc.
- Results
  - Water supply conditions
  - Water budget used by HYDROPS



Operations Modeling Suite

CALSIM II | **HYDROPS** | WQRRS | HEC-RAS

- Local operations model for Oroville Facilities operations
- Hourly time-step
- Simulate power generation on a weekly basis
- Subject to
  - Boundary conditions from CALSIM II
  - Facility operation constraints and criteria
- Results
  - Flow conditions and power generation
  - Operational scenario used by WQRRS



Operations Modeling Suite

CALSIM II | HYDROPS | **WQRRS** | HEC-RAS

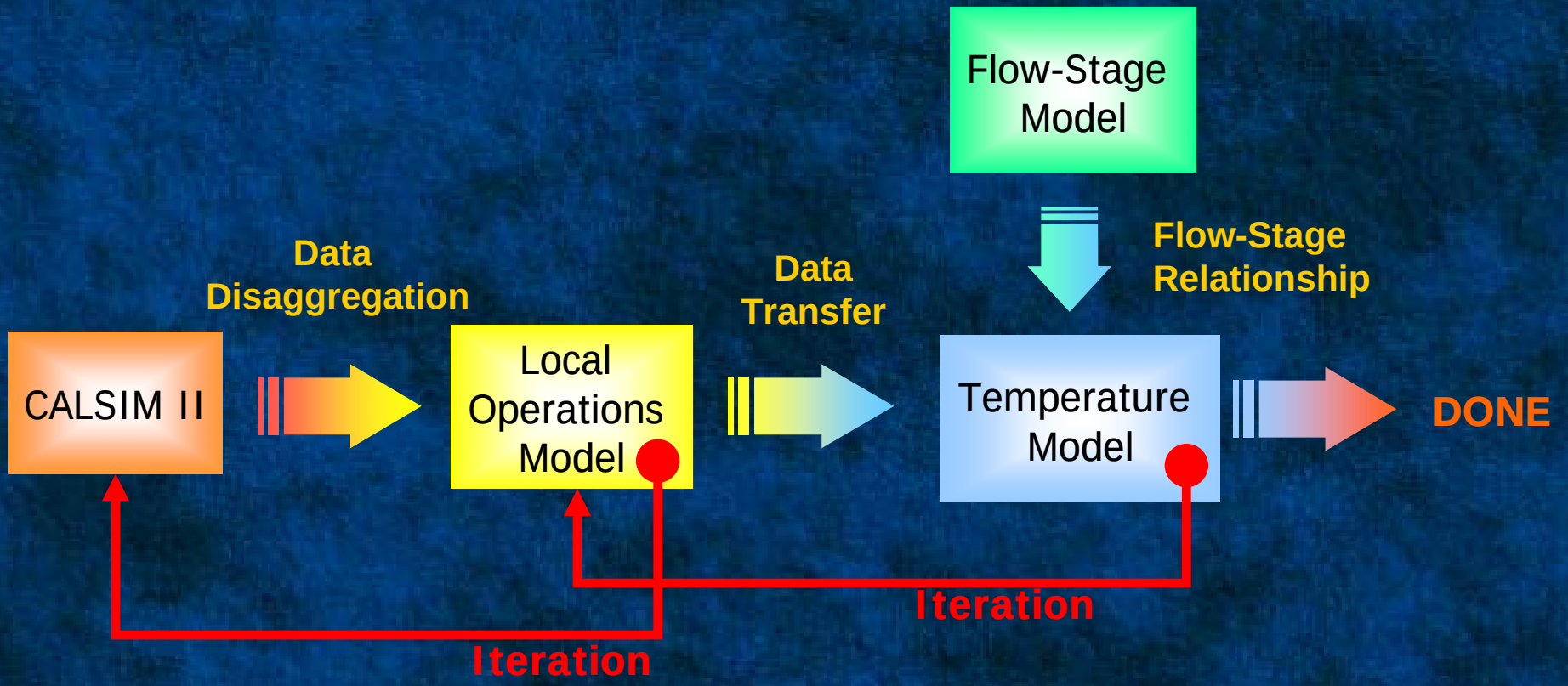
- Temperature model for Oroville Facilities and Feather River
- Hourly time-step
- Simulate reservoir and river temperatures for a given operational scenario
- Results
  - Reservoir and river temperature conditions
  - Indications of potential operational changes

Operations Modeling Suite

CALSIM II | HYDROPS | WQRRS | HEC-RAS

- Flow-stage model for Feather River below Oroville Dam to the confluence of the Sacramento River
- Cross section every ¼-mile
- Generate flow-stage relationship at a given location
- Focus on lower flow conditions (i.e., non-flooding conditions)
- Results
  - Static, unless changes in channel configuration
  - Flow-stage relationship used by WQRRS and other environmental studies

Operations Modeling Suite

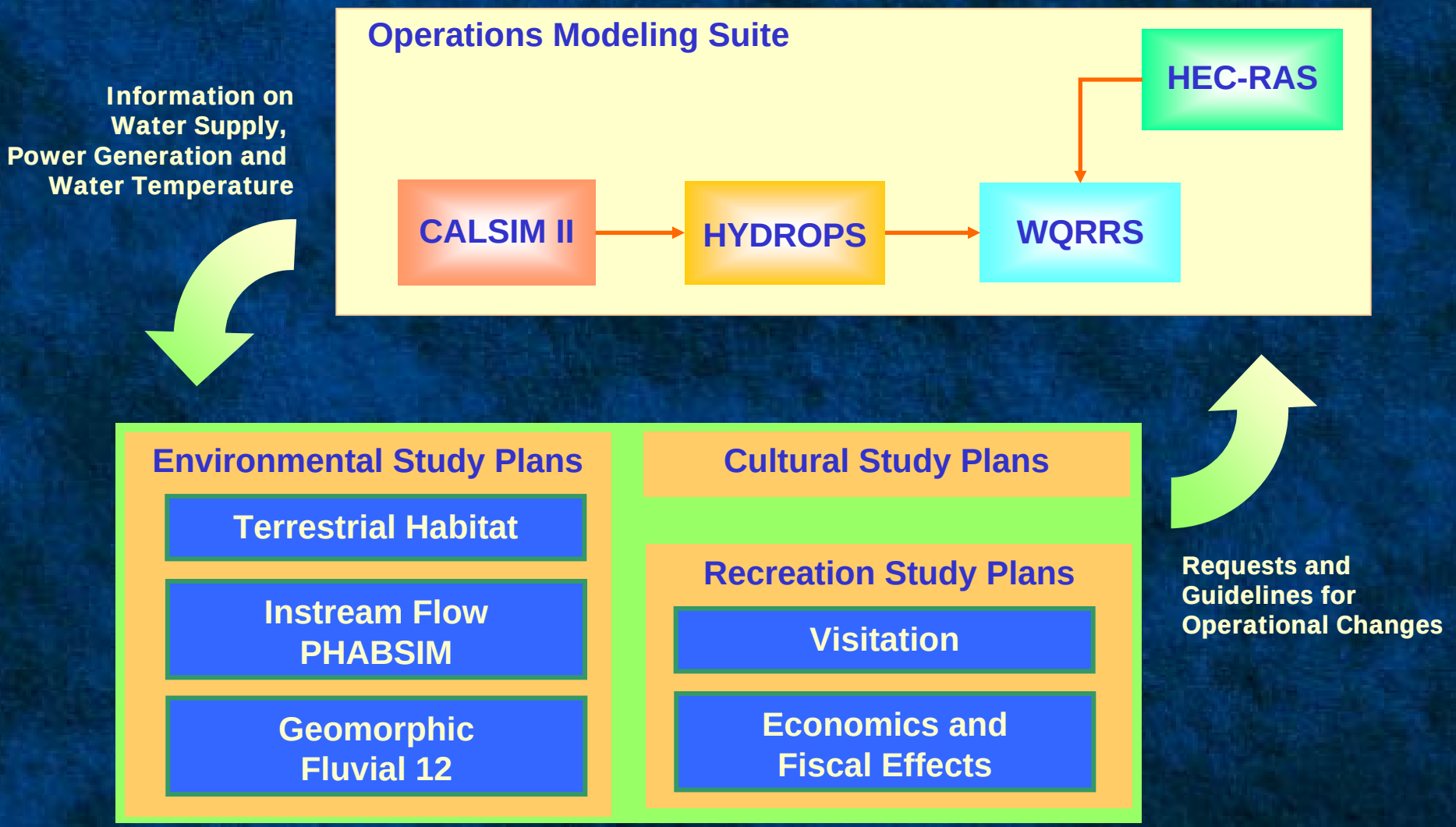


- Water supply conditions
- Monthly operations and water budget

- Power generation
- Hourly operations

- Reservoir temperature
- River temperature
- Ag diversion temperature

Relicensing Model Integration

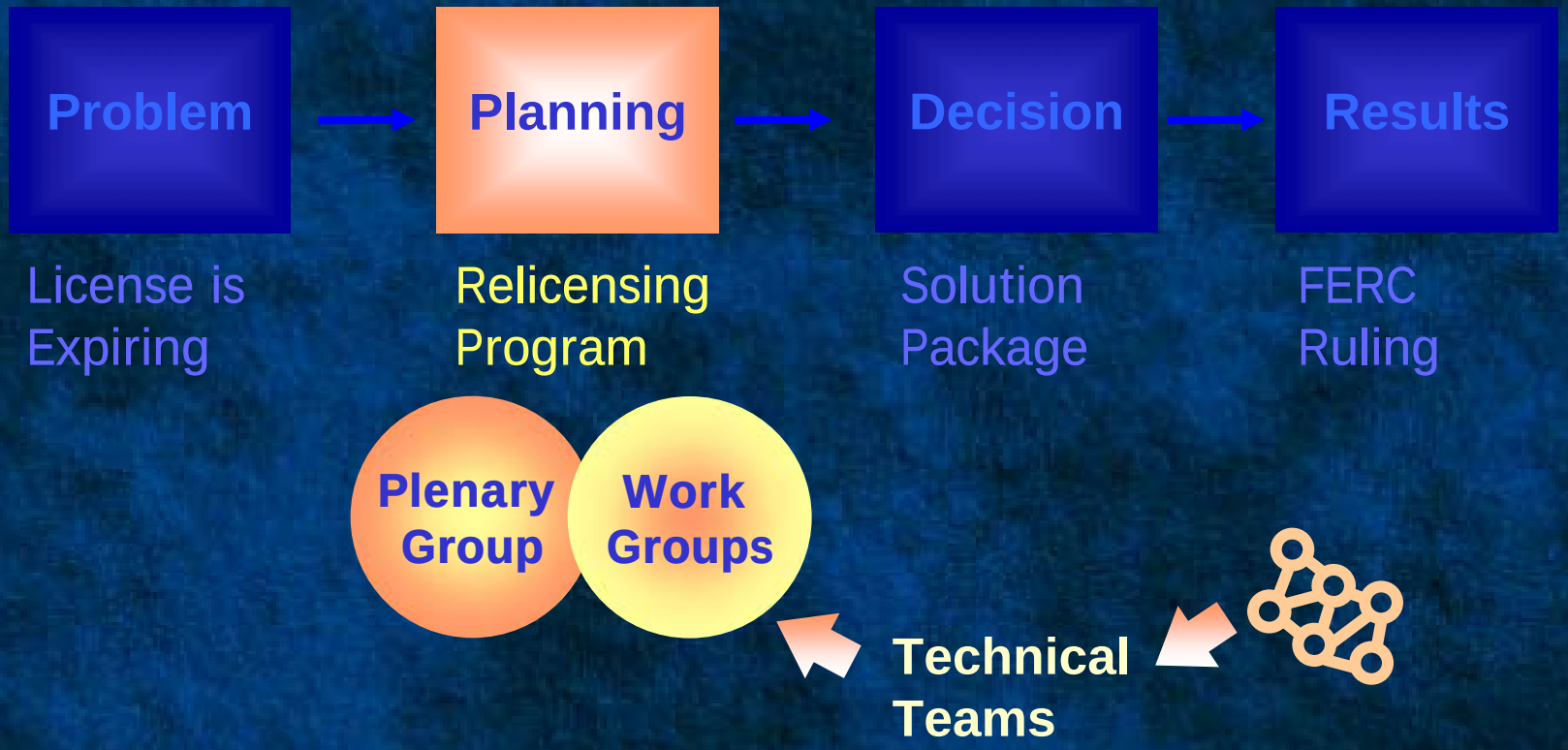


Matching Modeling Purposes

- "All models are wrong, but some are useful." - George Box, Professor, U. Wisconsin
- “Entities should not be multiplied unnecessarily.” - 14th century logician William of Occam
  - **Law of Parsimony**
- Albert Einstein,
  - "Make your theory as simple as possible, but no simpler."
  - "For every complex question there is a simple and wrong solution."

Matching Modeling Purposes

- Planning studies for Oroville Facilities Relicensing Program



Matching Modeling Purposes

- Planning vs. Forecasting
  - Different focus
    - Planning: relationship between causes and consequences
    - Forecasting: accuracy
  - Different criteria
    - Planning: reasonableness
    - Forecasting: accuracy

Matching Modeling Purposes

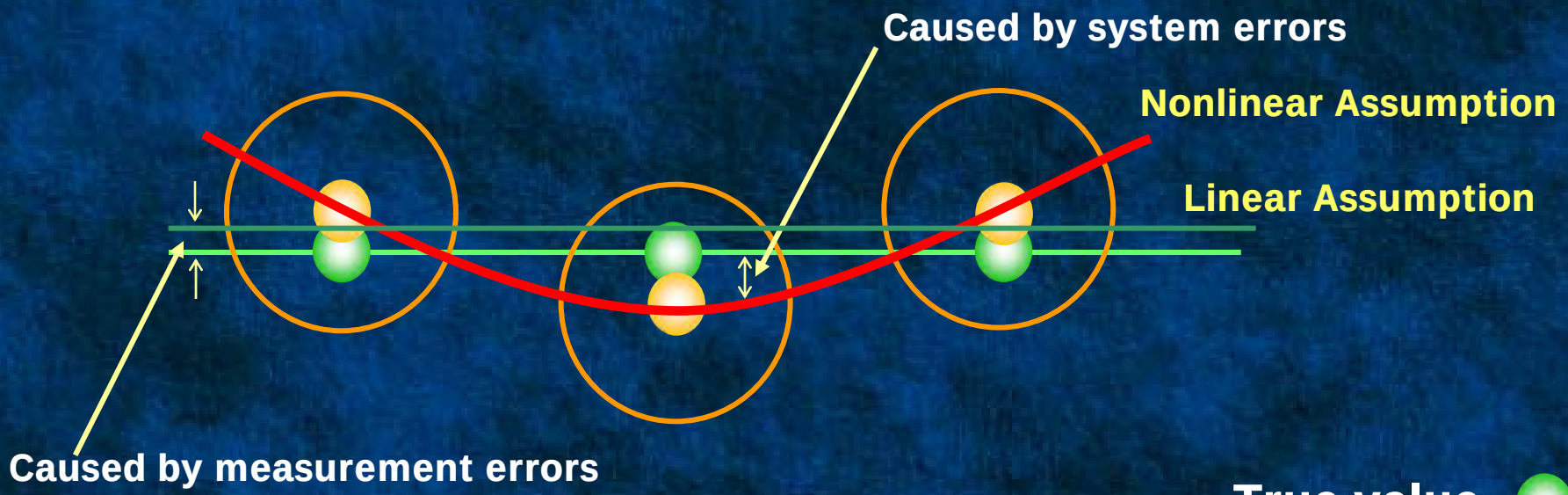
- Planning vs. Real-time Operations
  - Different level of risk management
    - Planning: long-term
    - Real-time: short- and/or near-term
  - Different criteria
    - Planning: trends
    - Real-time: avoiding jail time

Getting Right Information

- Modeling Errors
  - System errors: Assumptions on how the system works
  - Observation (measurement) errors: Data used to calibrate the model, built on the above assumptions, for its application

Getting Right Information

- Most of the time, both errors exist!



NOT TO SCALE

Getting Right Information

- Recognizing the Imperfect Modeling World
  - Common Sense Led Us to the Moon
  - Minimizing Potential System Errors
- Minimizing Impacts of Modeling Errors on Decision-Making
  - Focus on Reasonableness and Trends
  - Infer from Relative Changes between Scenarios
  - Consider Significance of the Relative Changes in a Real-World Sense
  - Look Past Unsupported Model Precision

Managing Modeling Efforts

- Objectives for managing modeling efforts
  - Address more requests
  - Support relicensing program more effectively
  - Provide quicker turnaround time
- Roles for achieving the objectives
  - Requestor(s)
  - Modeling coordinator
  - Modeling team members

POSTER

Managing Modeling Efforts

- Keys for managing modeling efforts
  - A complete modeling request
    - Resource-action-based objective(s)
    - Criteria and constraints
    - Measurement(s) of accomplishment
  - A modeling Plan with clear strategy
    - Modeling tools and requirements
    - Potential decision points for modification
  - An overall principle-in-charge
    - Operations Modeling Coordinator

Managing Modeling Efforts

- Operations Modeling Coordinator
- Working closely with requestor(s) and operations modeling team
- Responsibilities
  - Coordinate model development
  - Prioritize modeling requests
  - Match modeling requests with operation standards and criteria
  - Coordinate model implementation
  - Ensure exchange of right information

Hi, I am Curtis Creel

Managing Modeling Efforts

- Prioritizing Among Requests
  - Critical to relicensing program
  - Completeness of the request
  - Physical/legal/policy feasibility of proposed operational changes
  - Work load of team members
- Consolidating Requests
  - Finding common ground
  - Using representative conditions

Now, Let's Take a Break

Workshop Agenda

- Welcome and Introduction
- Operations Modeling for Oroville Relicensing
- Benchmark Study – Part 1
  - Definition
  - How we build, validate, and use it
  - An Operator's Perspective
- Lunch
- Benchmark Study – Part 2
- Discussion
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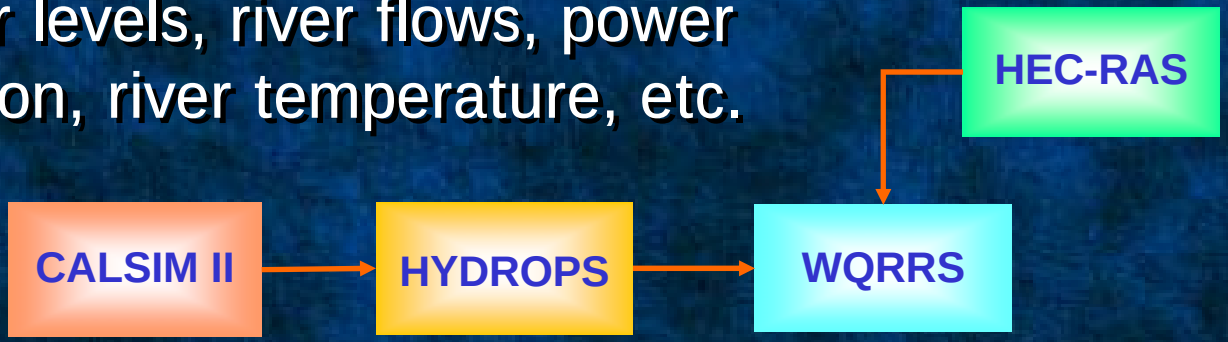
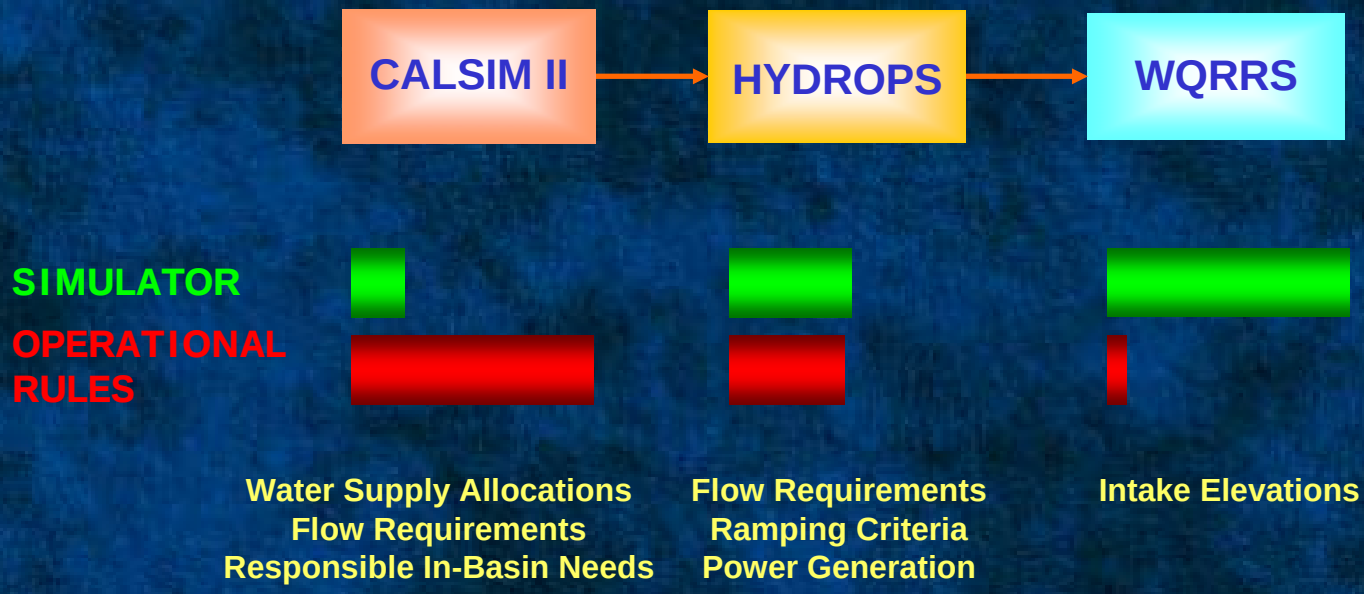
Benchmark Study
– Definition

- Purpose – Basis of comparison for evaluating resource action proposals
- Representation – Conditions described by the entire operations model suite
  - Water supply, reservoir storage, reservoir levels, river flows, power generation, river temperature, etc.



Benchmark Study
– Definition

- Operational rules associated with Oroville Facilities are captured in different models



Benchmark Study
– Variation and Perspective

- Required variation

  Workshop Focus

  – Existing Conditions – 2001 Level of Demand

  – Future Conditions – 2030 Level of Demand

- Perspective of future changes

  – Pending release of Future Conditions includes CALSIM II schematic changes may require re-evaluation of Existing Conditions

  – Revision of Benchmark Study could result in schedule delay for Relicensing process

  – IMPORTANT: Balancing modeling updates with FERC application schedule

Benchmark Study
– Establishing Details

- Reviewing results from every step for reasonableness of simulated operations
  - CALSIM II
  - Data disaggregation (monthly to weekly)
  - HYDROPS
  - WQRRS
- Recognizing CALSIM II's prominent role in establishing operational baseline

Benchmark Study
– Establishing Details, CALSIM II

- Important CALSIM II assumptions
  - Observe existing laws, regulations, agreements, water rights, and contract entitlements including
    - COA, D-1485, D-1641, FRSA entitlements, instream flow requirements, BO's, etc.
  - Assume SWP variable demands in relation to hydrology
    - Future conditions use the SWP "TABLE A" Allocation
  - Provide a minimum SWP allocation of 5%

Benchmark Study
– Establishing Details, CALSIM II

- Review of CALSIM II
  - Ongoing CALSIM II peer review process

    Supported by Relicensing Program
  - Simulation of historical operations (1975 to 1998)

    Performed outside of Relicensing Program
  - Qualitative assessment on simulated SWP operation

    Performed for Relicensing Program

DETAILS

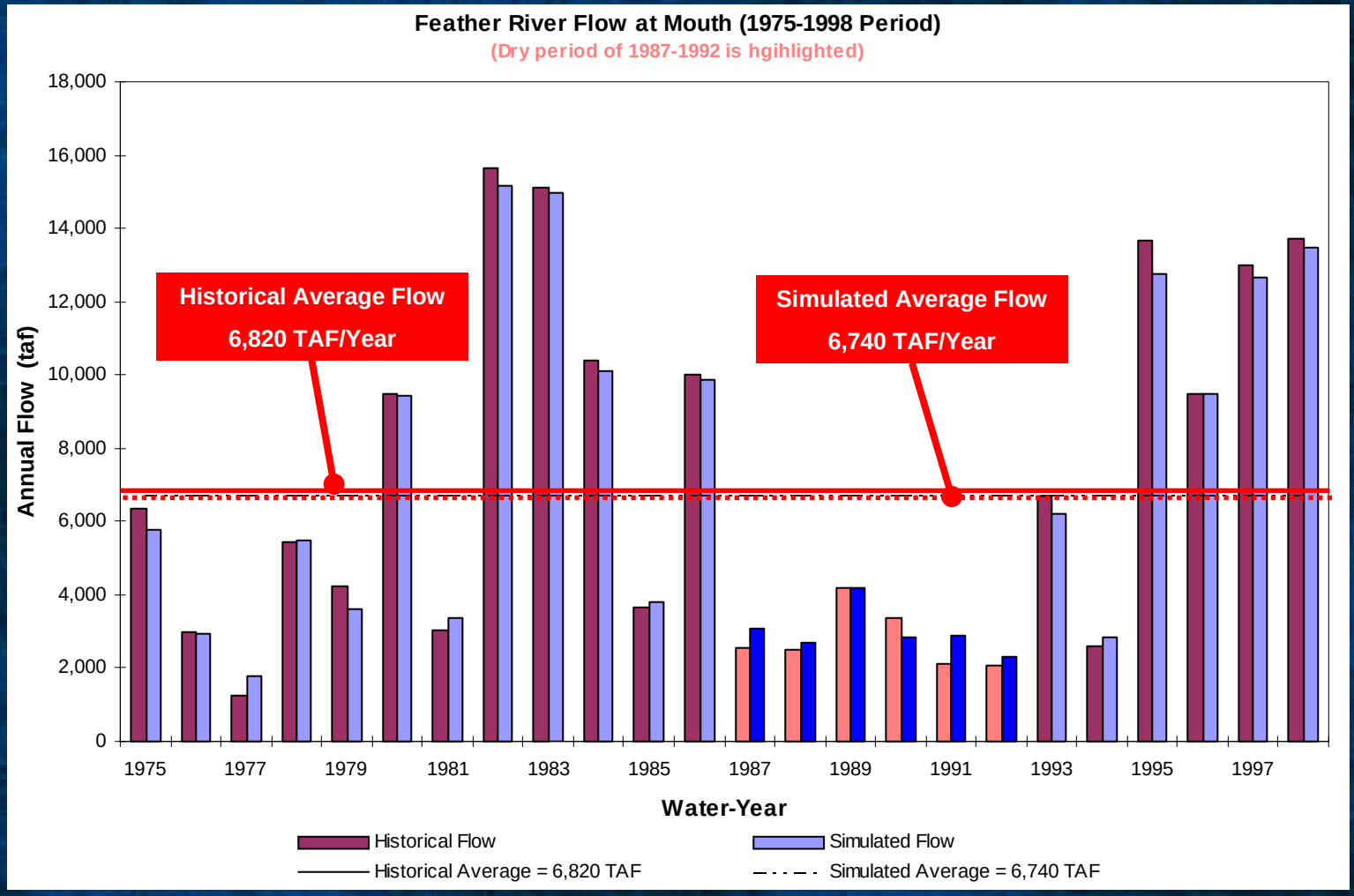
DETAILS

Benchmark Study
– Establishing Details, CALSIM II

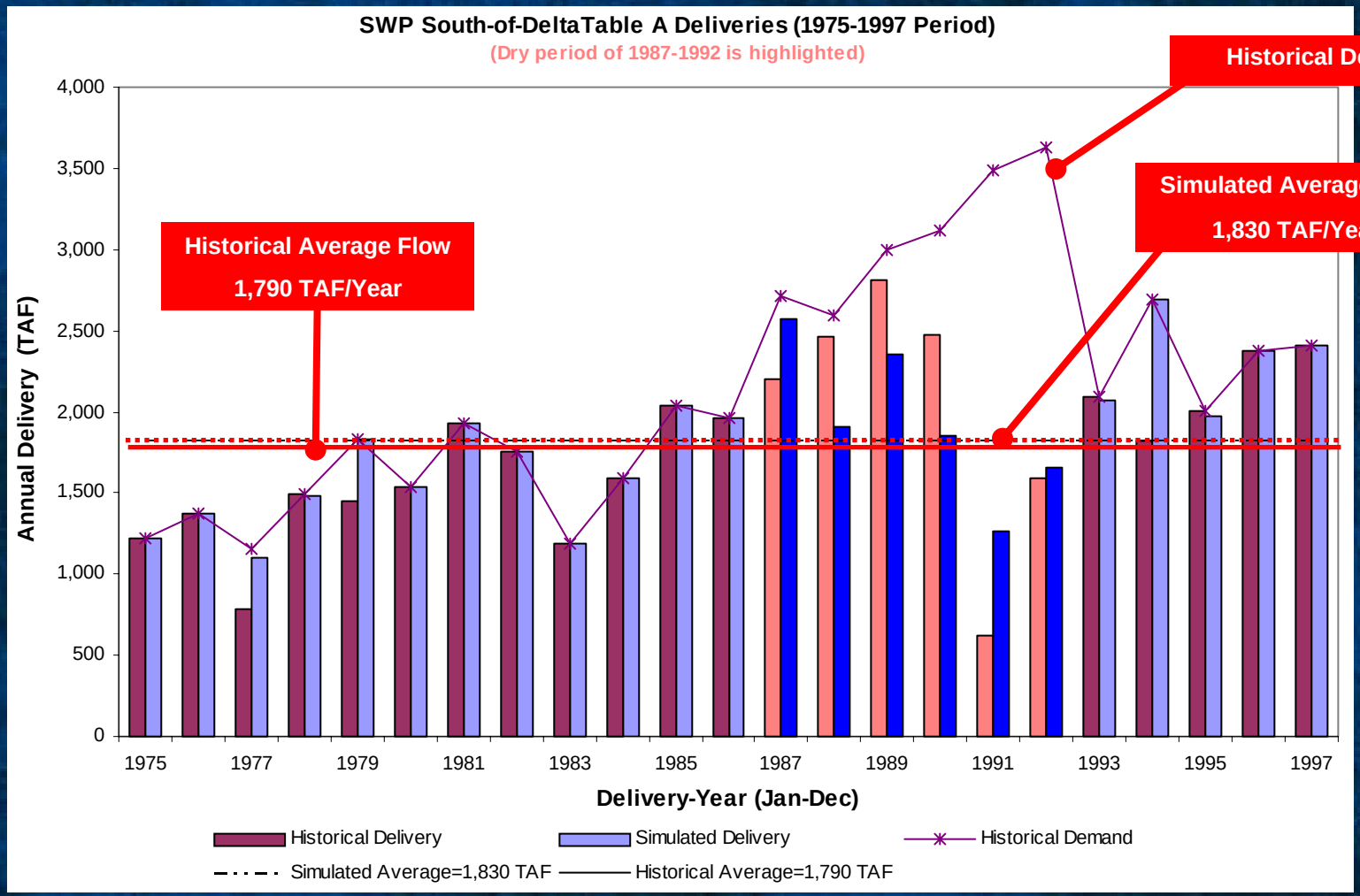
- Simulation of historical operations (1975 through 1998)
  - A review by DWR Planning Dept.
  - Features:
    - Applying consistent rules for SWP allocation
    - Including historical demands
    - Changing regulations, such as
      - SWRCB D-1485 (1978)
      - SWRCB WQCP (1995)
    - Ignoring incidental changes of operation due to fishery, mechanical, and other considerations

Different from normal CALSIM II applications

Benchmark Study
– Establishing Details, CALSIM II

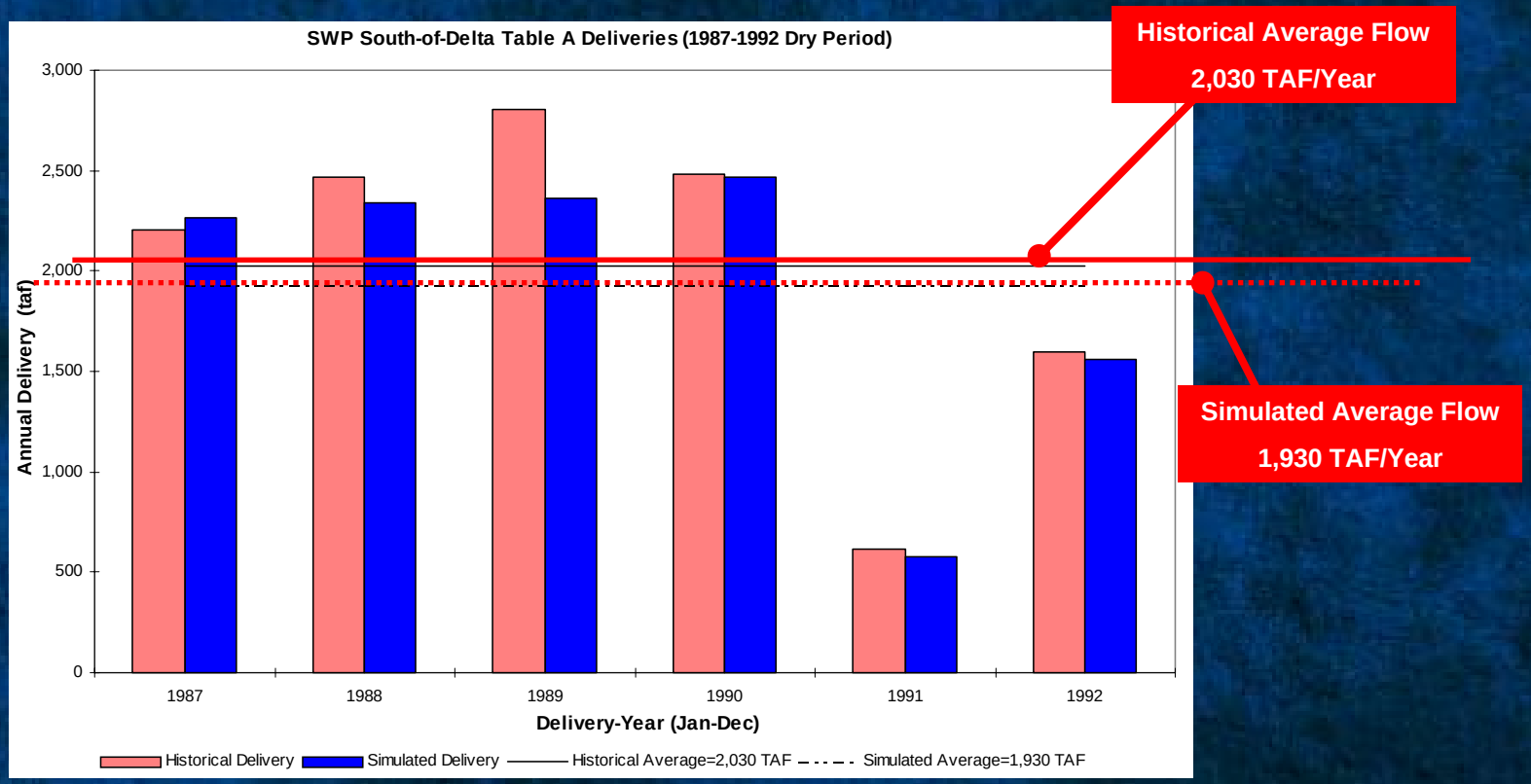


Benchmark Study
– Establishing Details, CALSIM II



Benchmark Study
– Establishing Details, CALSIM II

- Adjustment: if we convert storage to delivery, as an operator would do in this condition



Benchmark Study
– Establishing Details, CALSIM II

- Findings of the Simulation of historical operations (1975 through 1998)
  - The study is not a usual CALSIM II application
  - Comparison with historical operations is favorable
  - CALSIM II simulates SWP allocation with a consistent level of aggressiveness (or conservativeness)
  - In reality, Oroville Facilities operators' judgment calls for SWP allocation may vary from year to year

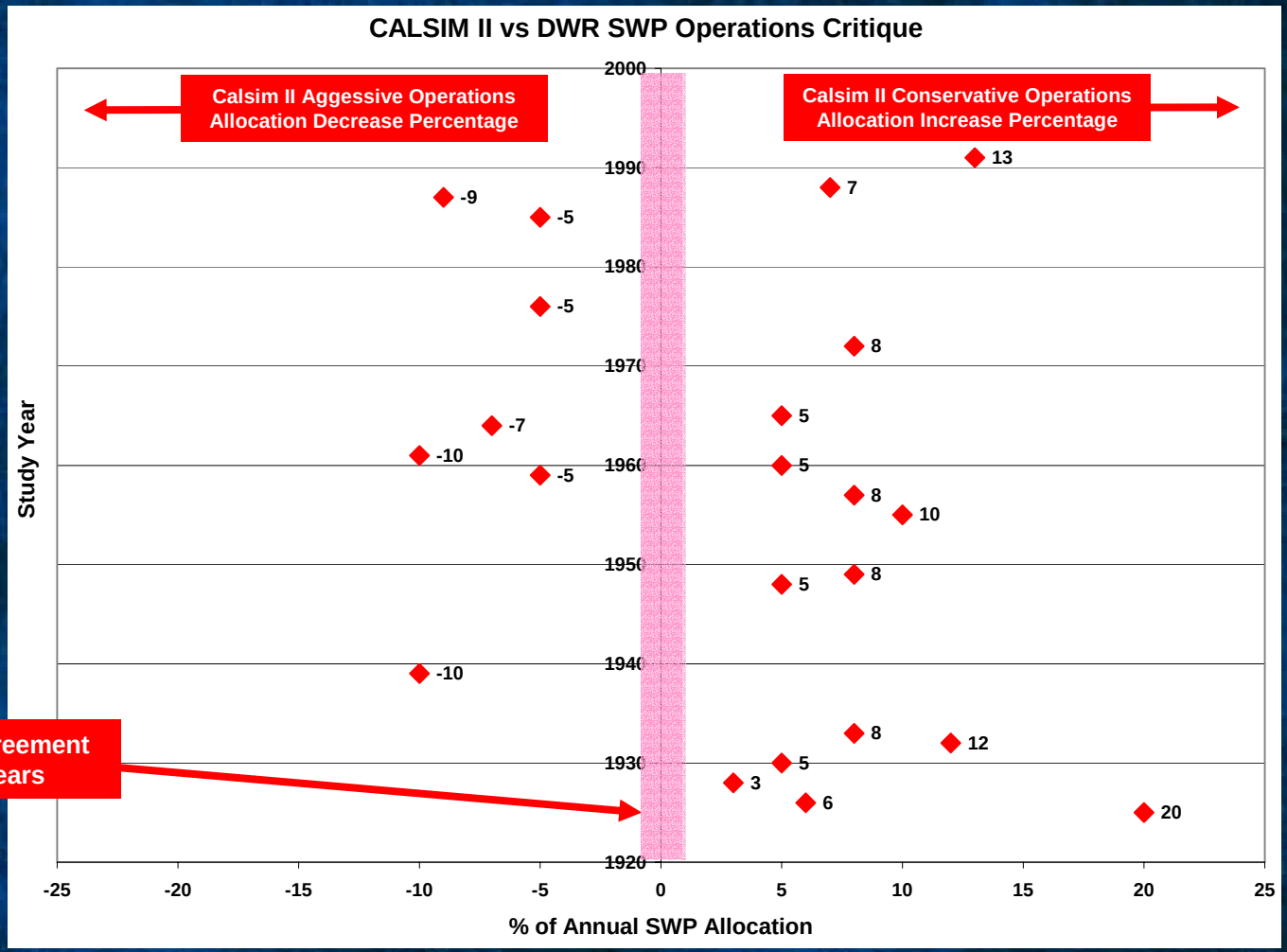
Benchmark Study
– Establishing Details, CALSIM II

- Qualitative assessment on simulated SWP operations
  - Evaluating simulated operations of 73-year period from operators' viewpoint
  - Reviewing operations by asking a series of key questions
  - Excluding 1977 and 1994 calendar years
    - 1977: extreme year with little representation of SWP operation
    - 1994: incomplete year at the end of the simulation period

Benchmark Study
– Establishing Details, CALSIM II

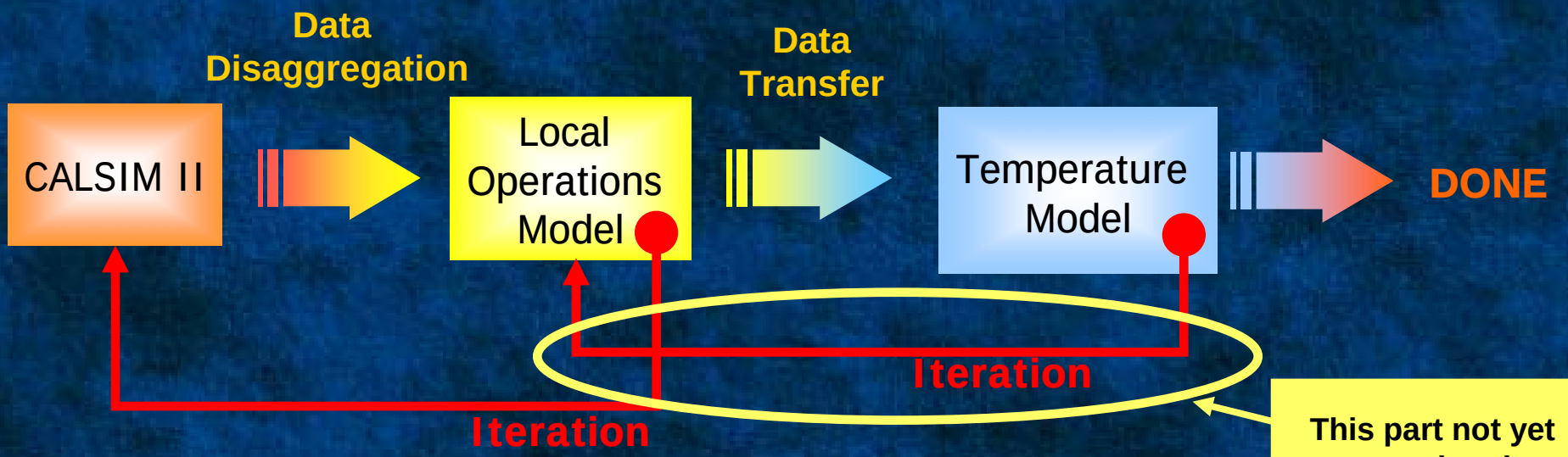
- Key questions for qualitative assessment on simulated SWP operations
  - Reservoir Storage (Oroville and SWP San Luis)
    - Are the end of water year storages excessive?
    - Are the end of water year storages too low?
  - SWP Delivery Allocation
    - Does CALSIM II over-allocate, or solve aggressively?
    - Does CALSIM II under-allocate, or solve conservatively?
  - SWP Export at the Delta
    - Is the Banks Pumping Plant's capacity used sufficiently and within constraints?
  - Would we as Operators have operated differently?
    - Would we trade allocation for storage?
    - Would we trade storage for allocation?

Benchmark Study
– Establishing Details, CALSIM II



We have an agreement in 68% of years

Benchmark Study
– Establishing Details



- Water supply conditions
- Monthly operations and water budget

- Power generation
- Hourly operations

- Reservoir temperature
- River temperature
- Ag diversion temperature

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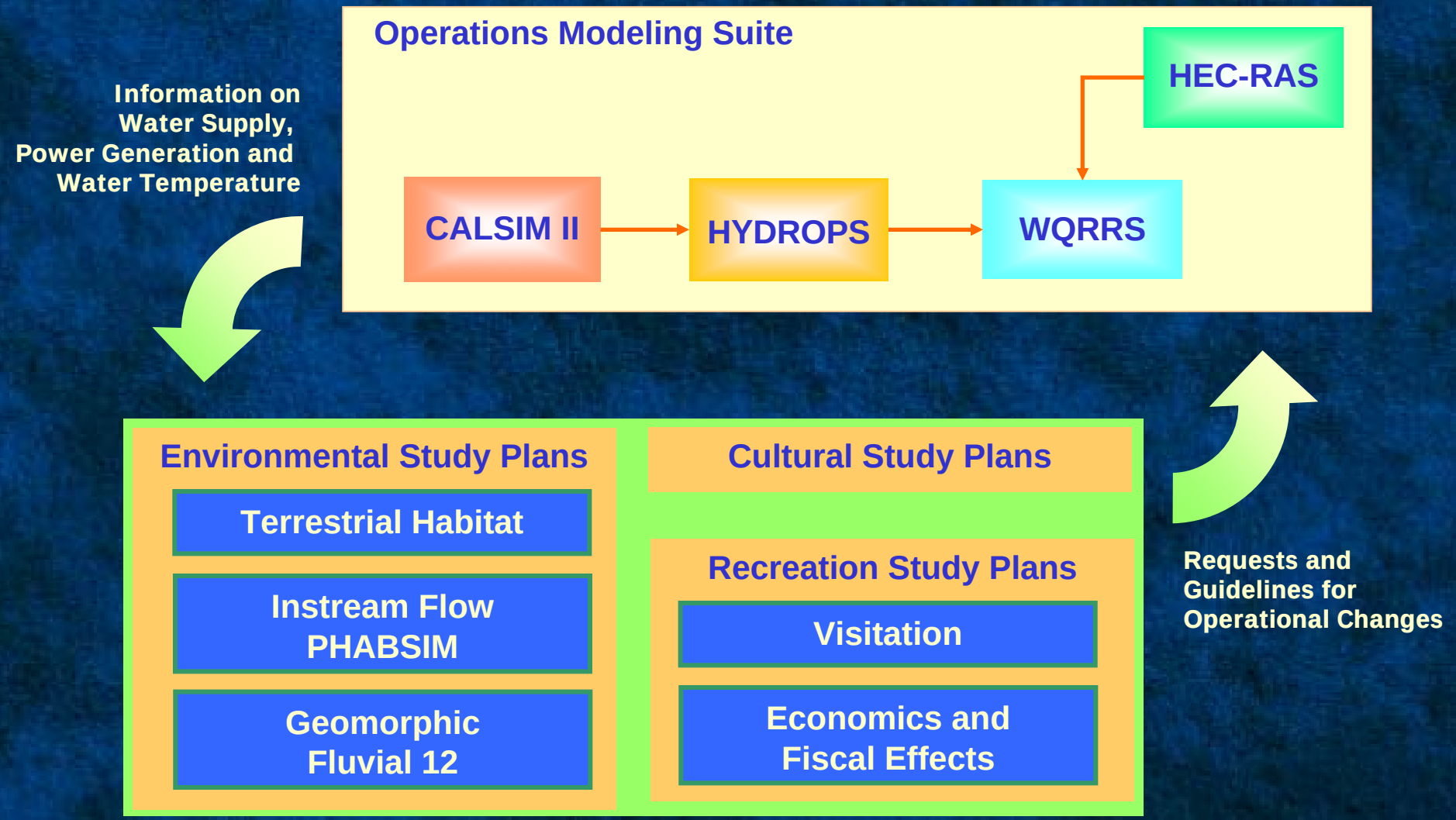
Relicensing Model Integration – A Recap



Matching Interests and Operations Modeling Outputs

- Recreation Interests
  - Oroville Levels
  - Low Flow Channel Flows
  - Thermalito Afterbay Fluctuation and Elevation
- Agricultural Interests
  - Diversion Temperatures
  - Deliveries

Matching Interests and Operations Modeling Outputs

- Cultural Interests
  - Oroville Levels
- Water Supply Interests
  - State Water Project South-of-Delta Deliveries
  - Feather River Service Area Deliveries

Matching Interests and Operations Modeling Outputs

- Power Interests
  - Hyatt Power Plant generation
    - On peak
    - Off peak
    - Pump-back
  - Thermalito Power Plant generation
  - Thermalito Diversion Dam Power Plant generation

Matching Interests and Operations Modeling Outputs

- Fishery Interests
  - Lake Oroville levels
  - Thermalito Afterbay levels and fluctuations
  - Oroville Cold Water Pool
  - River temperature
    - Low Flow Channel
    - Robinson Riffle
    - Above and below the Afterbay
    - Above and below the Yuba River
  - River flows in the Low Flow Channel

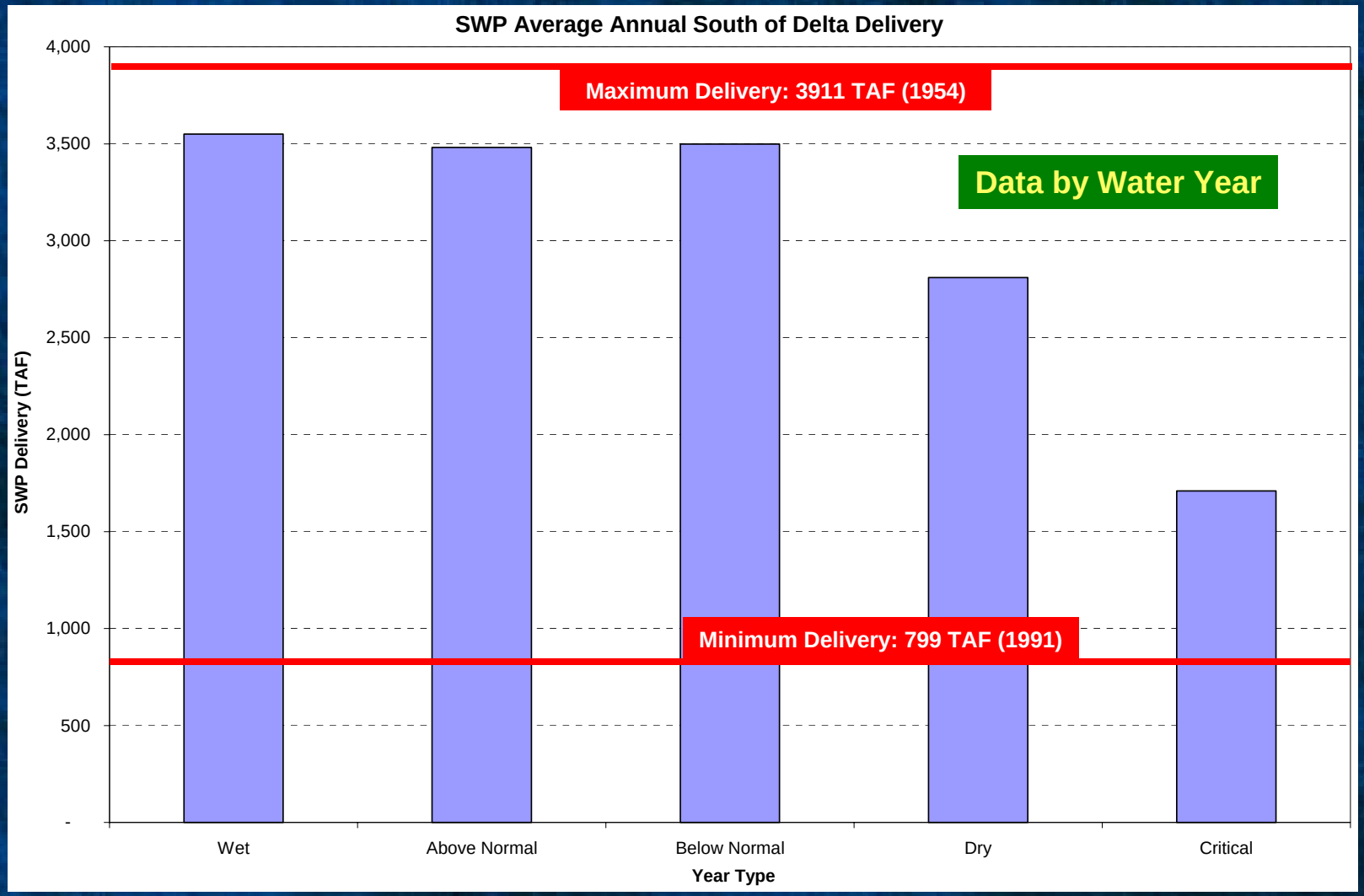
Benchmark Study Results
– Existing Conditions

- Results Summary
  - – Water supply **CALSIM II** **Water Supply**
    - SWP allocation
  - – Power generation **HYDROPS** **Power Generation** *Pending*
    - Annual power generation with pump back %
    - On/off peak comparison
    - Monthly pattern with pump back %
  - – Temperature **WQRRS** *Pending*
    - Agricultural diversions in Afterbay **Agricultural**
    - River temperature at Robinson Riffle **Environmental**

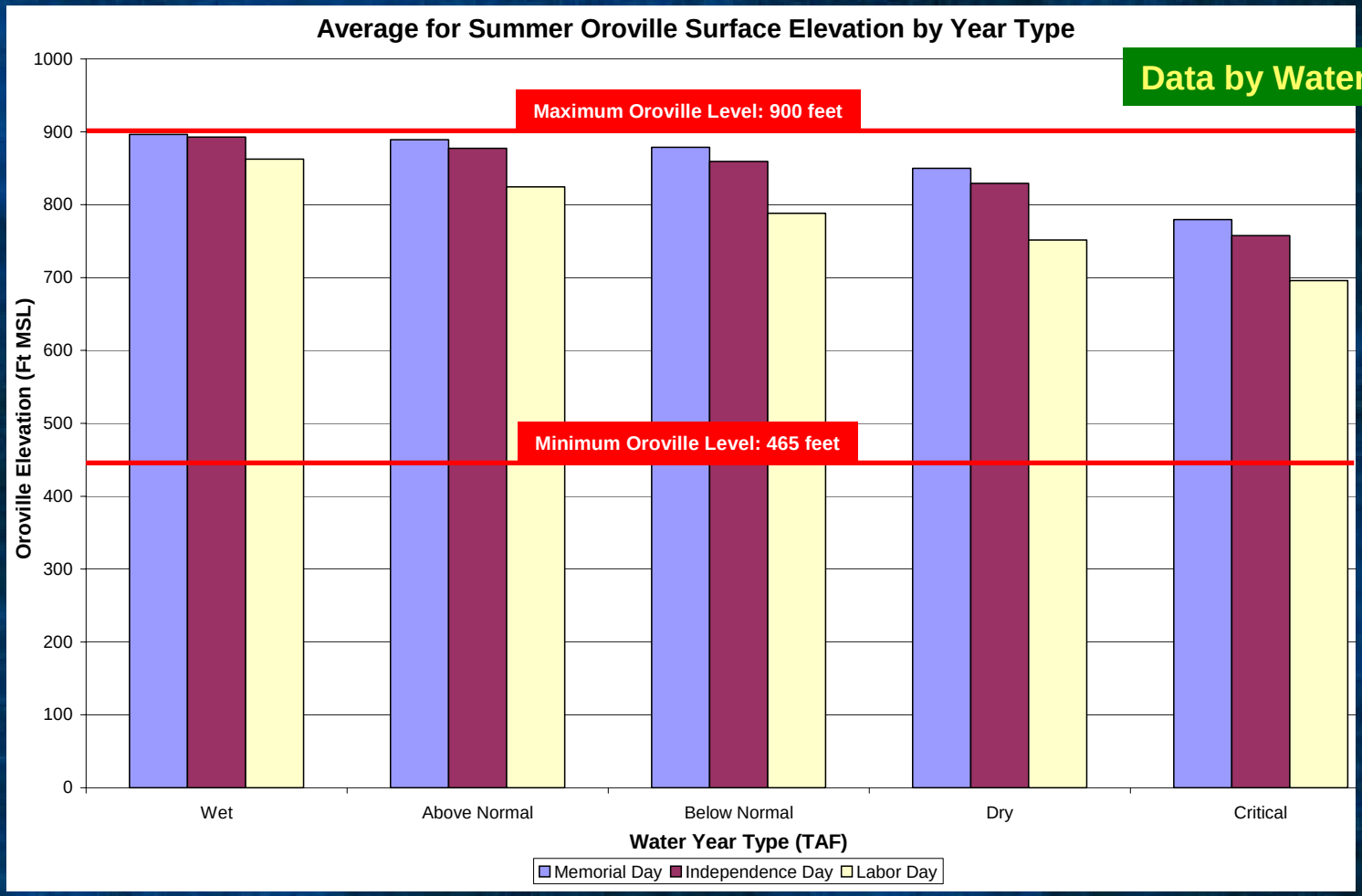
Benchmark Study Results
– Existing Conditions

- Results Summary
  - Reservoir Levels **CALSIM II** **Recreation**
    - Memorial day
    - Independence Day
    - Labor Day
  - River flows **CALSIM II** **All**
    - Reasons for Releasing from Oroville Reservoir
- Samples of output presentation

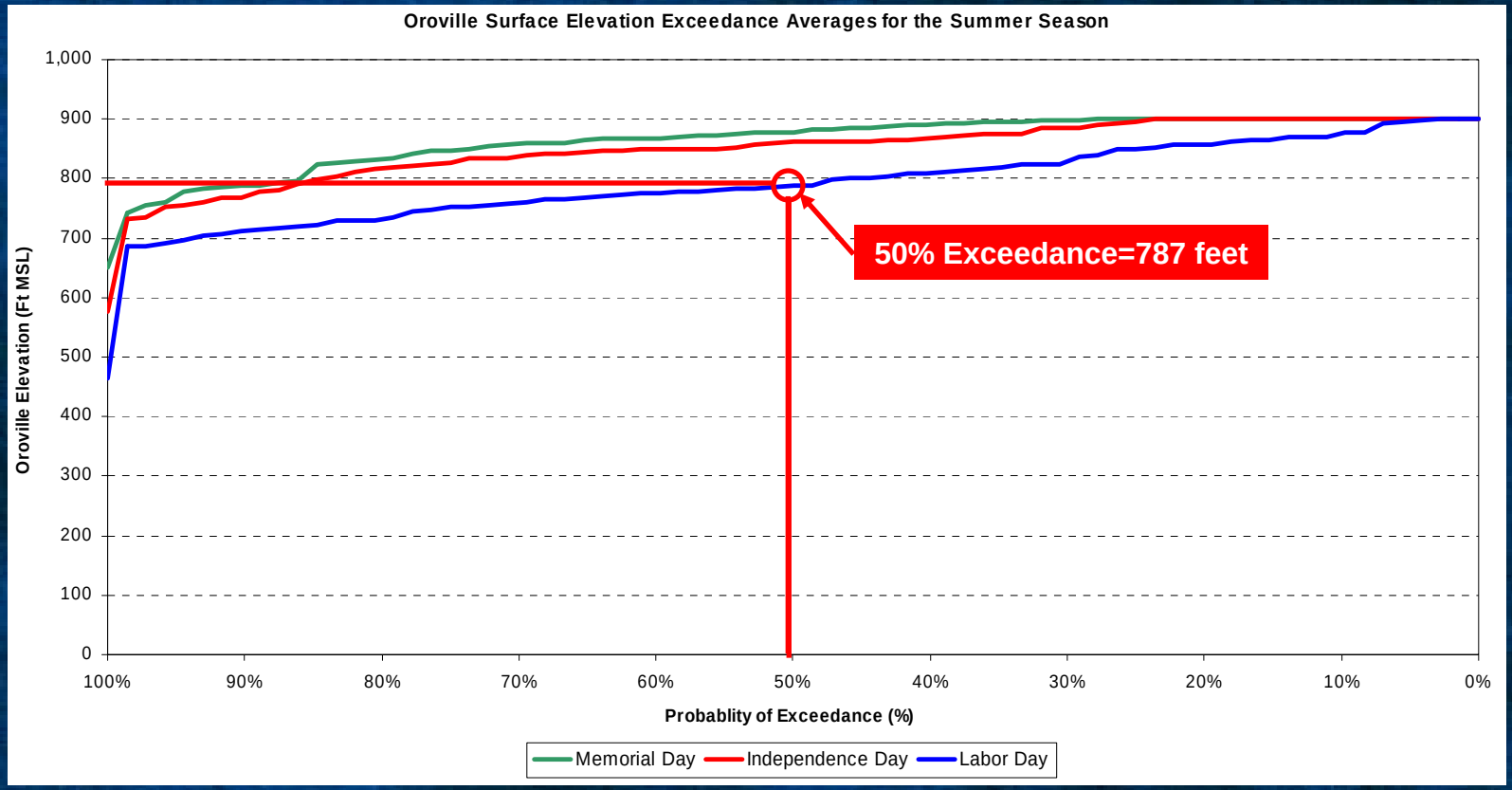
Benchmark Study Results
– Existing Conditions



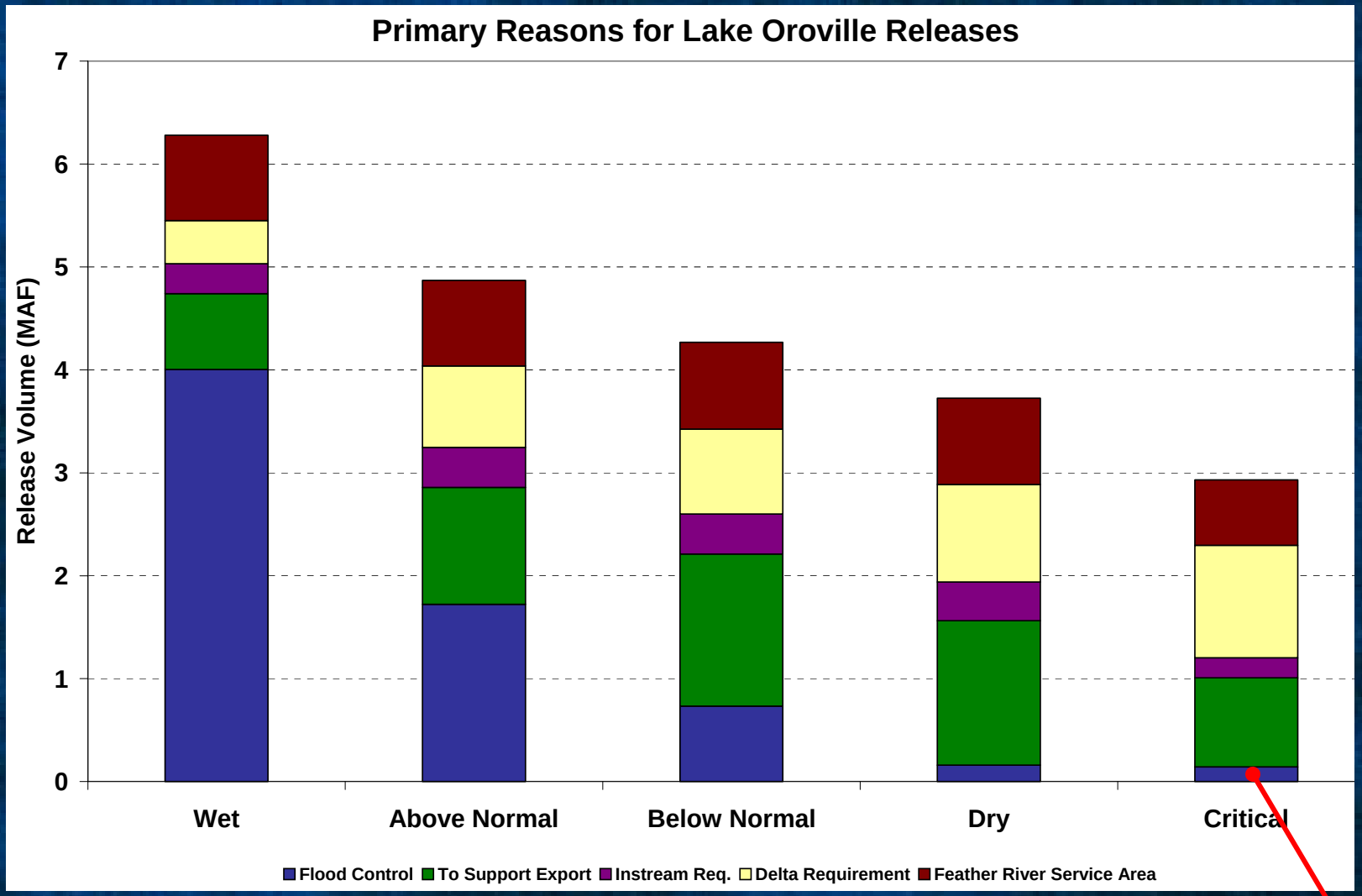
Benchmark Study Results
– Existing Conditions



Benchmark Study Results
– Existing Conditions



Benchmark Study Results
– Existing Conditions



1976 and 1994

Now, Let's Take a Break

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Next Steps

- When is the next workshop?
- What will be discussed in the next workshop?
  - Sensitivity analysis of Benchmark
  - Bookend Analyses
- In the future, proposed resource actions proposals will be addressed

Additional Information

Operations Modeling Coordinator

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Modeling Documentation and Administration

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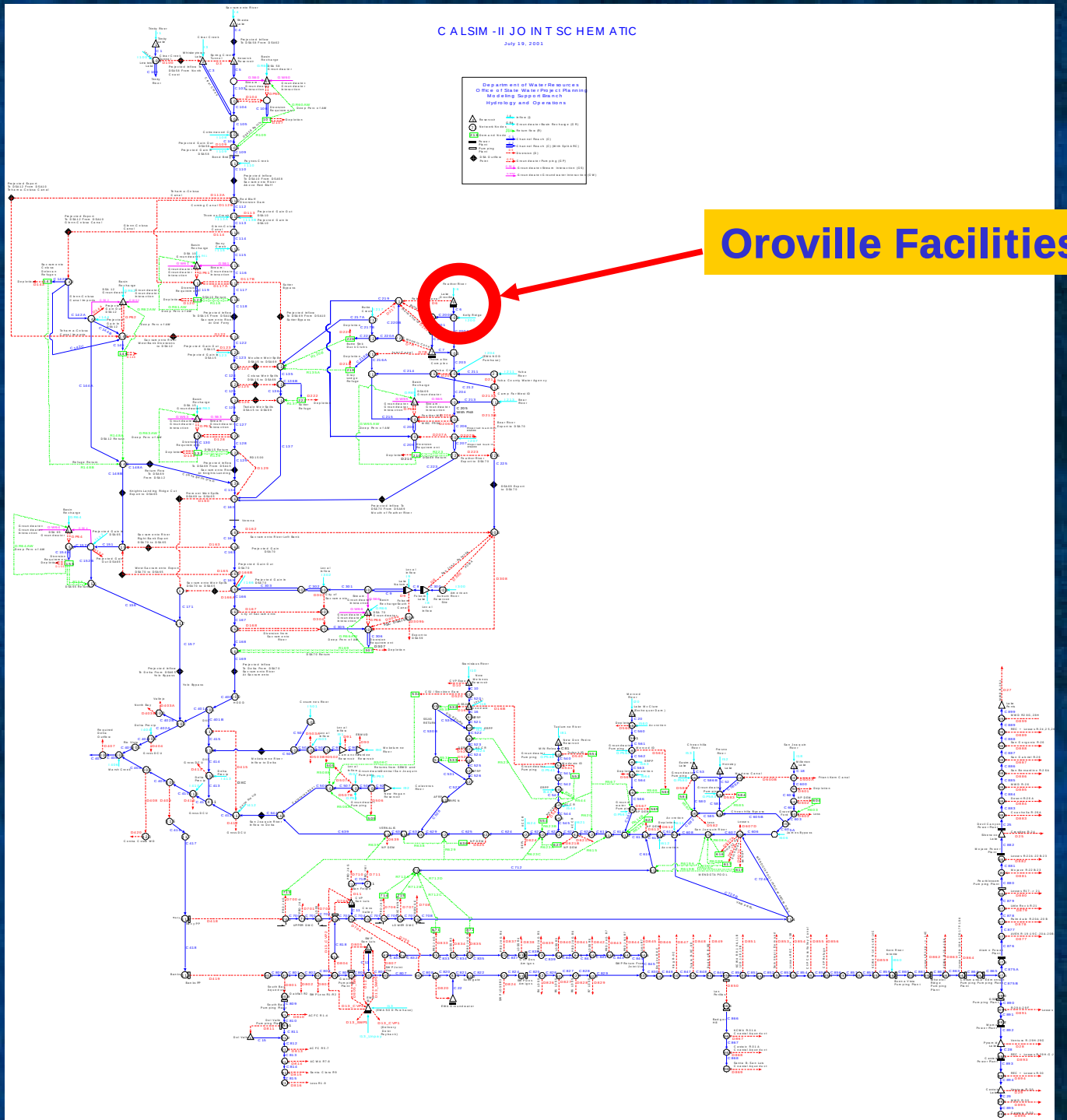
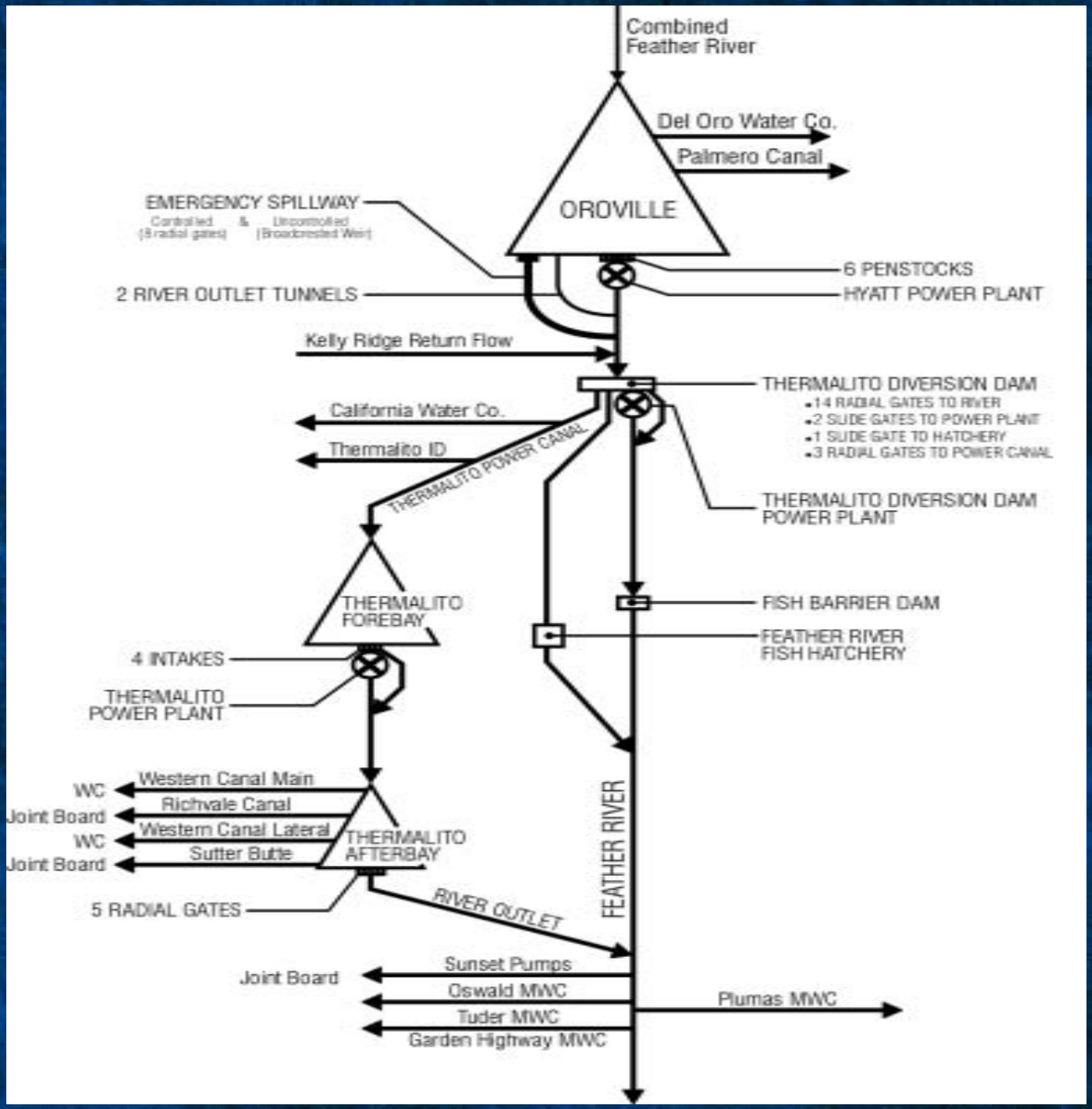
August 12, 2003


CALSIM-II JOINT SCHEMATIC
July 19, 2001
Department of Water Resources
Office of State Water Project Planning
Modeling Support Branch
Hydrology and Operations
Oroville Facilities

Back


Combined
Feather River
Del Oro Water Co.
Palmero Canal
OROVILLE
EMERGENCY SPILLWAY
Controlled (8 radial gates) & Uncontrolled (Broadcrested Weir)
6 PENSTOCKS
HYATT POWER PLANT
2 RIVER OUTLET TUNNELS
Kelly Ridge Return Flow
THERMALITO DIVERSION DAM
•14 RADIAL GATES TO RIVER
•2 SLIDE GATES TO POWER PLANT
•1 SLIDE GATE TO HATCHERY
•3 RADIAL GATES TO POWER CANAL
California Water Co.
Thermalito ID
THERMALITO POWER CANAL
THERMALITO DIVERSION DAM POWER PLANT
THERMALITO FOREBAY
FISH BARRIER DAM
FEATHER RIVER FISH HATCHERY
4 INTAKES
THERMALITO POWER PLANT
Western Canal Main
WC
Richvale Canal
Joint Board
Western Canal Lateral
WC
Sutter Butte
Joint Board
THERMALITO AFTERBAY
5 RADIAL GATES
RIVER OUTLET
FEATHER RIVER
Joint Board
Sunset Pumps
Oswald MWC
Tuder MWC
Garden Highway MWC
Plumas MWC

Back